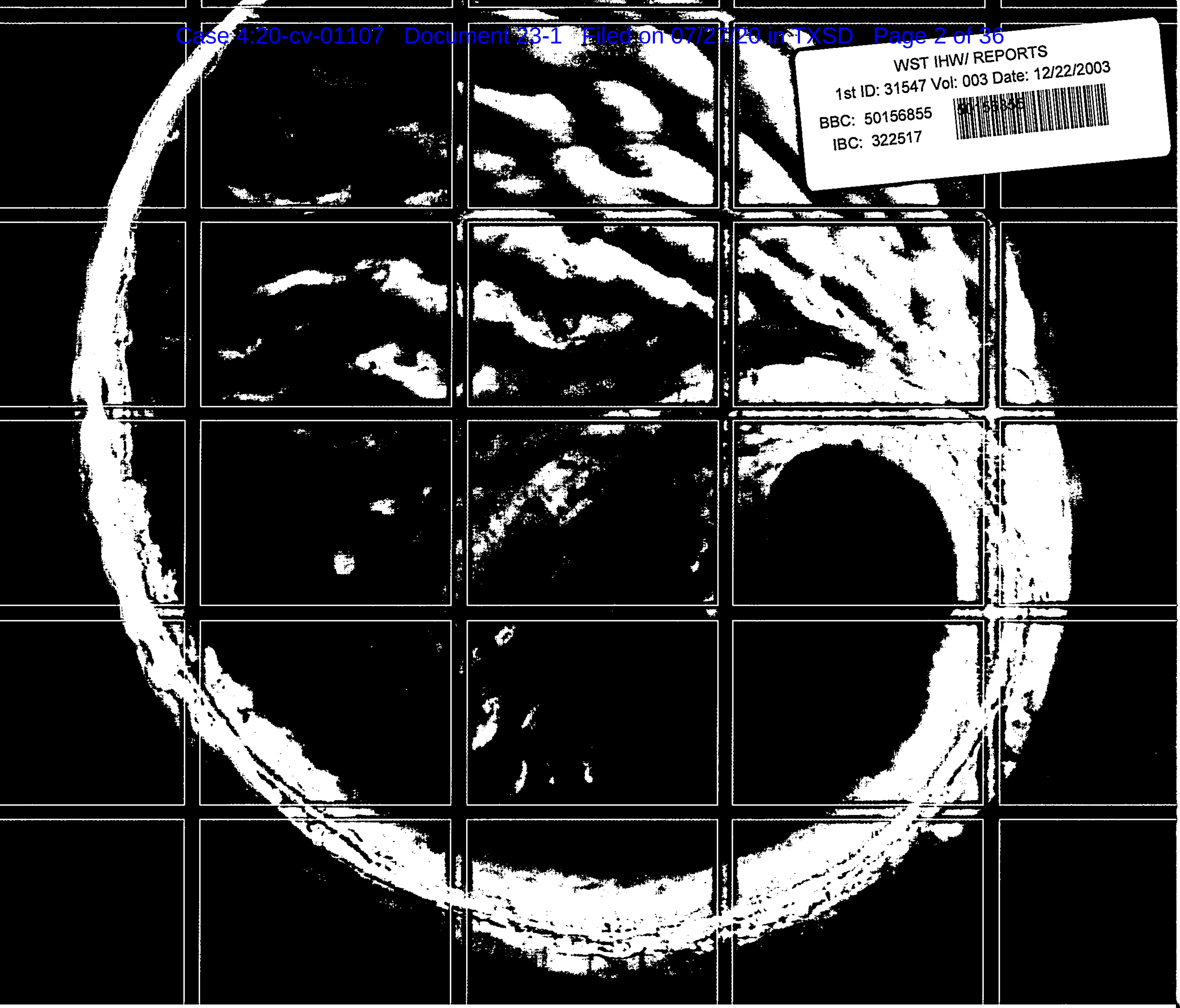
EXHIBIT A



Part B Application Renewal and Amendments

Union Pacific Railroad Houston Tie Plant
SWR: 31547
4910 Liberty Road
Houston, Texas

December 22, 2003

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Part B Renewal Application and Amendments

Union Pacific Railroad Houston Tie Plant
Houston, Texas
W.O.# 422-102

December 2003

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Environmental Resources Management

1110 Montlimar Drive
Suite 150
Mobile, AL 36609
(251) 380-0046
(251) 380-0552 (fax)

RECEIVED
DEC 29 2003
Air & Waste Applications Team

ERM.

December 22, 2003

Texas Commission on Environmental Quality
Attention: Permits Administrative Review Section, MC-161
Registration, Review & Reporting (RR&R) Division
12100 Park 35 Circle, Building F
Austin, Texas 78753

W.O. #422-102

Subject: Submittal of RCRA Permit and Compliance Plan Renewal Application with Major Amendment for Union Pacific Railroad Houston Tie Plant, SWR: 31547

Dear Sir or Madam:

Union Pacific Railroad is submitting a renewal application for the RCRA Permit and Compliance Plan with Major Amendments for the above-mentioned facility. Pursuant to the TCEQ's instructions, please find enclosed the following documents:

- The original RCRA Part B Application plus three (3) full copies;
- Six (6) additional copes of Section I: General Information;
- Four (4) copies of the Preliminary Review Checklists provided under separate cover;
- A photostatic copy of the check for payment of permit renewal application fees transmitted directly to the TCEQ Financial Administration Division;
- A photostatic copy of the check for payment of permit application fee for a major amendment transmitted directly to the TCEQ Financial Administration Division;
- The original Compliance Plan Application plus three (3) full copies; and
- A photostatic copy of the check for payment of Compliance Plan renewal application fees transmitted directly to the TCEQ Financial Administration Division.

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DEC 29 2003
Air & Waste Applications Team

A major amendment is sought during the renewal period to update the permit and compliance plan with conditions at the facility and changes requested by the TCEQ since 1994.

The following has been sent to the Financial Administration Division:

RECEIVED
DEC 9 2003
Air & Waste Applications Team

- The check for payment of RCRA Permit renewal application fees;
- The check for payment of RCRA Permit application fee for a major amendment; and
- The check for payment of Compliance Plan renewal application fees.

Please contact me at (251) 380-0046 if you have any questions or require anything further.

Sincerely,

Environmental Resources Management

Paul Stefan, P.G.
DD/std

cc: TCEQ Financial Administration Division (payments only)
Geoffrey B. Reeder, Union Pacific Railroad Company

Figures

December 22, 2003
W.O. #422-102/60
Union Pacific Railroad
Houston Wood Preserving Works
Houston, Texas

Environmental Resources Management
1110 Montlimar Drive, Suite 150
Mobile, Alabama 36609
(251) 380-0046

OVERSIZE DOCUMENTS, MAPS & PHOTOS

Record Series: IHW

File #: 31547 ID# 50156855

The below listed documents, from the above referenced file, that belong in this location in the file were not microfilmed because of their size and/or media format. See the Central File Room staff for the location of the following oversize documents and/or photographs:

DATE ON DOCUMENT	DESCRIPTION OF DOCUMENT
12/22/2003	REPORT ERM - SOUTHWEST, INC,
	FIG. 1 FACILITY LOCATION AND
	LAYOUT MAP HOUSTON, TX SHEET NO. 1 of 1

SWMU AREAS

NO.	DESCRIPTION
SWMU 1	INACTIVE SURFACE IMPOUNDMENT

LEGEND

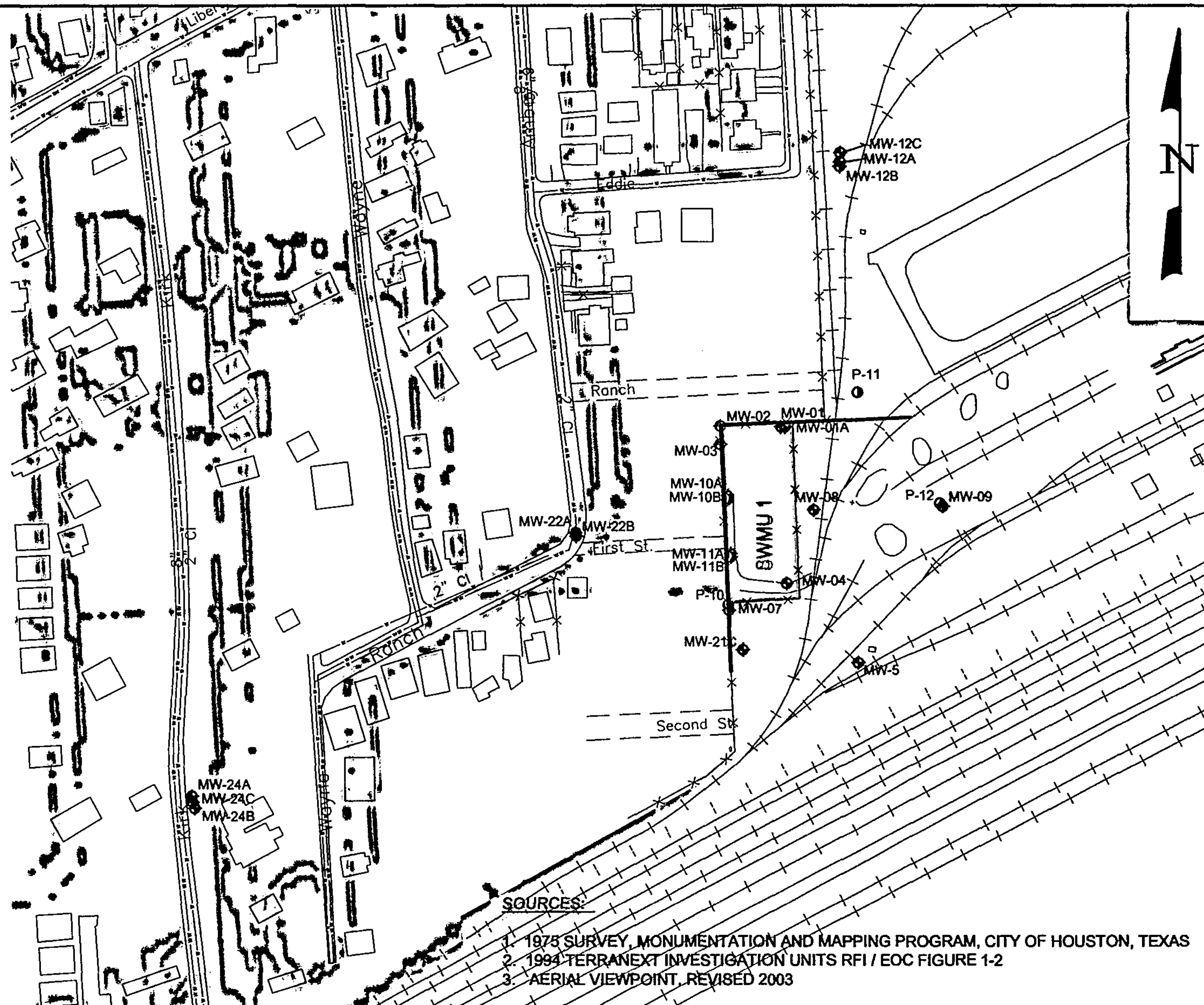
- MW-5 MONITOR WELL
- HISTORIC STRUCTURES AND FEATURES
- ROADS, PARKING LOTS, SIDEWALKS
- FENCES
- RAIL LINES
- RIGHTS-OF-WAY
- STORM SEWER
- SANITARY SEWER
- WATER LINES
- UPRR PROPERTY
- POINT OF COMPLIANCE LINE

NOTE:

1. NOR #001 IS SAME AS SWMU 1

0 200 400

SCALE FEET



SOURCES:

1. 1975 SURVEY, MONUMENTATION AND MAPPING PROGRAM, CITY OF HOUSTON, TEXAS
2. 1994 TERRANEXT INVESTIGATION UNITS RFI / EOC FIGURE 1-2
3. AERIAL VIEWPOINT, REVISED 2003

ERM-Southwest, Inc.

HOUSTON · NEW ORLEANS · AUSTIN · MOBILE · BEAUMONT · BATON ROUGE · CORPUS CHRISTI

DESIGN: TMO	DRAWN: RLM/MMH	CHKD.: DD/TS
DATE: 12/04/03	SCALE: AS SHOWN	REV.:
W.O.NO.: G:\Cad\422-102\L03\422102D01L03R0.dwg, 12/10/2003 15:45:13		

FIGURE 2
PERMITTED UNIT LOCATION MAP
HOUSTON WOOD PRESERVING WORKS
HOUSTON, TEXAS

ERM

Adjacent Land Owners List

Attachment A

December 22, 2003
W.O. #422-102/60
Union Pacific Railroad
Houston Wood Preserving Works
Houston, Texas

Environmental Resources Management
1110 Montlimar Drive, Suite 150
Mobile, Alabama 36609
(251) 380-0046

LANDOWNERS CROSS-REFERENCED TO APPLICATION MAP

The persons identified below would be considered as affected persons.

1. FREDDIE BRAZOS
2210 KIRK ALLEY
HOUSTON TX 77026

2. EVON D. COOPER
7225 GORE
HOUSTON TX 77016

3. BETTY LOUISE WILLIAMS
4414 QUITMAN
HOUSTON TX 77026

4. ISAAC & GRACE WILLIAMS
4416 QUITMAN
HOUSTON TX 77026

5. COMMUNITY HOME BUYERS CLUB
7437 YOE
HOUSTON TX 77016

6. WILSON BOATWRIGHT
4424 QUITMAN
HOUSTON TX 77026

7. EUSTAQUIO BANDA
4428 QUITMAN
HOUSTON TX 77026

8. EUSTAQUIO BANDA
4428 QUITMAN
HOUSTON TX 77026

9. INDUSTRIAL GAS SUPPLYCORP
PO BOX 2628
HOUSTON TX 77252

10. R B DEREBERY
RT 2 BOX 139
WHITESBORO TX 76273

11. TERRY LOUISE ELLIOTT
1705 SCHWEIKHA
APT B
HOUSTON TX 77020

12. FIFTH WARD COMMUNITY
REDEVELOPMENT
PO BOX 21502
HOUSTON TX 77226

13. MARY L CRAIN WILEY
2604 AMBOY
HOUSTON TX 77026

14. GWENDOLYN D OWENS
10609 WOODWICK
HOUSTON TX 77016

15. CHAS L SHEFFIELD
2618 AMBOY
HOUSTON TX 77026

16. HESTER HENDERSON
4508 EDDIE
HOUSTON TX 77026

17. HARRISON TURNER
2509 SAKOWITZ
HOUSTON TX 77020

18. SHIRLEY A WHITEHEAD
2803 KASHMERE ST
HOUSTON TX 77026

19. LEONA ROSIGNON
4518 COURTNEY
HOUSTON TX 77026

20. TEDDIE PHILLIPS
4513 COURTNEY
HOUSTON TX 77026

21. HOMER BOOKER
CHARLOTTE GREER
8139 MARCY DR
HOUSTON TX 77033

22 GUMMY JOE SHAN
9811 ROLKE ROAD
HOUSTON TX 77099

23. ALICE AYALA SAMUDIO
4517 LIBERTY
HOUSTON TX 77026

24. GABRIEL ZEPEDA
2714 E SOUTHMORE
PASADENA TX 77502

25. ALICE AYALA SAMUDIO
4517 LIBERTY ROAD
HOUSTON TX 77026

26. CLARETHA PHONE MARKS
3511 WAYNE
HOUSTON TX 77026

27. PAUL FRUGE
PO BOX 557
HOUSTON TX 77001

28. FISHER DEMITRA & ETAL
PO BOX 21298
HOUSTON TX 77226

29. RAY P MONTALBANO
7838 PECAN VILLAS
HOUSTON TX 77061

30. WILLIE H. GOFFNEY
4110 RAND
HOUSTON TX 77026

31. CLARK INVESTMENT CO
4901 LIBERTY ROAD
HOUSTON TX 77026

32. GREATER MT NEBO BAPTISH
CHURCH
4511 EDDIE
HOUSTON TX 77026

33. ALBERTA SMITH
5010 WYLIE
HOUSTON TX 77026

34. ROBERT & JANIE LONGORIA
512 EAST 11TH STREET
HOUSTON TX 77008

35. ALEJANDRO GONZALES
5105 LIBERTY ROAD
HOUSTON TX 77026

36. JOE H MARTINEZ
5109 LIBERTY ROAD
HOUSTON TX 77026

37. ERIC & CHERYL MATHEWS
2717 RALSTON
HOUSTON TX 77026

38. MARTIN HALICK
5117 LIBERTY ROAD
HOUSTON TX 77026

39. FULL GOSPEL CHRISTIAN ASSN
5201 LIBERTY ROAD
HOUSTON TX 77026

40. CHARITY BAPTISH CHURCH
& REV F W MCILVEEN
2809 ERASTUS STREET
HOUSTON TX 77026

41. GENEVA HENRY
5301 LIBERTY ROAD
HOUSTON TX 77026

42. SANDHILL PRIME LTD
PO BOX 291589
KERRVILLE TX 78029

43. ANDREW J FLAKE
5921 ENGLEFORD
HOUSTON TX 77026

44. EDWARD HUGHES
5421 LIBERTY ROAD
HOUSTON TX 77026

45. ANDREW & JOSIE CARROLA
6518 KURY LANE
HOUSTON TX 77008

46. FREDI R SAKOWITZ
3311 SAKOWITZ
HOUSTON TX 77026

47. MAXSIMION M SALAS
5621 LUCILLE
HOUSTON TX 77026

48. ROBERT DAMIAN
3300 EAST LOCKWOOD
HOUSTON TX 77026

49. LUTCHEY MCCALL
2702 CHEW
HOUSTON TX 77020

50. WOODROW JOHNSON
5602 BRUMBACH
HOUSTON TX 77020

51. WOODROW JOHNSON
2512 SAM WILSON
HOUSTON TX 77020

52. MOLZAN INC.
817 WESTHEIMER
HOUSTON TX 77006

53. LINDA J WILLIAMS
2610 CHEW
HOUSTON TX 77020

54., ELLEN PIERCE
2602 CHEW
HOUSTON TX 77020

55. JENNIFER CURTIS
2602 CHEW
HOUSTON TX 77020

56. UNION BAPTIST BIBLE COLLEGE
2600 CHEW STREET
HOUSTON TX 77020

57. SECOND MT OLIVE
2523 CHEW STREET
HOUSTON TX 77020

58. HAROLD J HENRY
9215 LOCKWOOD
HOUSTON TX 77016

59. MORGAN MALONE
5839 WILLOW GLEN
HOUSTON TX 77033

60. BESSIE B SAMUEL
4614 WIPPRECHT
HOUSTON TX 77026

61. TRUDIE THOMAS
PO BOX 1473
LAPORTE TX 77571

62. F B KING MOORE
8225 TREMONT
HOUSTON TX 77028

63. EMMA MCGOWAN
8117 PARKER ROAD
HOUSTON TX 77078

64. JAMES C MCCANN JR
3314 WAYNE STREET
HOUSTON TX 77026

65. T E STEPTOE
7319 GORE
HOUSTON TX 77016

66. PATRICIA D RUSHER
15223 MESA BLVD
HUMBLE TX 77396

67. G R WASHINGTON
3715 RIO VISTA
HOUSTON TX 77021

68. ROY & GERTRUDE ADAMS
2214 ERASTUS
HOUSTON TX 77020

69. LUCILE WILLIAMS
2308 ERASTUS
HOUSTON TX 77020

70. GLORIA EATMON
5301 LEE
HOUSTON TX 77020

71. ALEE MACKEY
7932 CORINTH
HOUSTON TX 77051

72. ROBBIE M JOHNSON
2416 ERASTUS
HOUSTON TX 77020

73. WILSON ALLEN
5301 SUEZ STREET
HOUSTON TX 77020

74. ALBERT J ZARZANA
12322 KIMBERLY
HOUSTON TX 77024

75. ROY & GERTRUDE S ADAMS
2214 ERASTUS
HOUSTON TX 77020

76. BRYANT SMITH
5305 NICHOLS
HOUSTON TX 77020

77. AUBREY MURRAY
11560 LINK STREET
LOS ANGELES CA 90061

78. ROY & GERTRUDE S ADAMS
2214 ERASTUS
HOUSTON TX 77020

79. LEROY AMEY
4610 MAJESTIC
HOUSTON TX 77026

80. ULYSSES JONES
4304 NICHOLS
HOUSTON TX 77020

81. DON JOHNSON
3917 LOCKWOOD DR
HOUSTON TX 77026

82. ULYSSES & EUNICE JONES
3917 LOCKWOOD
HOUSTON TX 77026

83. RICHARD LEWIS
5210 MARKET STREET #9
HOUSTON TX 77020

84. BOBBIE & ISAAC HENSLEY
5118 LEE
HOUSTON TX 77020

85. WILLIAM E JOHNSON
5114 LEE
HOUSTON TX 77020

86. L WHITAKER JR
5102 LEE
HOUSTON TX 77020

87. C & ETHYL L HARRIS
6210 DARLINGHURST
HOUSTON TX 77085

88. JEFF & RENDIE EDWARDS
5010 LEE
HOUSTON TX 77020

89. MATTIE LEE NELMS
5006 LEE
HOUSTON TX 77020

90. DORA G BELL
5002 LEE
HOUSTON TX 77020

91. PETE M & CAMELLA M CHIARA
206 GLENVILLE
HOUSTON TX 77024

92. MRS BERTHA GRIFFIN
4810 LEE
HOUSTON TX 77020

93. WILLIAM E JOHNSON
5114 LEE
HOUSTON TX 77020

94. GREGORY K RICHARD
4800 LEE
HOUSTON TX 77020

95. GREATER MT SHARON
MISSIONARY BAPTIST CHURCH
4722 LEE
HOUSTON TX 77020

96. CLARENCE & REVA JOYCE ROSS
2943 ALMEDA PLAZA
HOUSTON TX 77045

97. MABSON ETAX DOCKERY
4702 LEE
HOUSTON TX 77020

98. M WOODLEY
10902 CHEEVES
HOUSTON TX 77016

99. VICKY DAVIS
4201 LOS ANGELES ST
HOUSTON TX 77020

100. ANNIE E MEEKS
7745 JAMES FRANKLIN
HOUSTON TX 77088

101. E DAVIS
4612 LEE
HOUSTON TX 77020

102. HAROLD & IRMA WASHINGTON
7610 SOUTHHALL
HOUSTON TX 77028

103. ARTHUR & MARY SMITH
4520 LEE
HOUSTON TX 77020

104. OLETHA WESLEY
4512 LEE
HOUSTON TX 77020

105. CORINE A & TOMMIE HEADS JR
4506 LEE
HOUSTON TX 77020

106. ARTHUR LEE & MARY SMITH
4502 LEE
HOUSTON TX 77020

107. GENTRY THOMAS
5826 THRUSH
HOUSTON TX 77033

108. MRS BEWLAH H MCGOWEN
5214 LYONS AVENUE
HOUSTON TX 77020

109. ETHA L ELLIS
5033 PAULA
HOUSTON TX 77033

110. JAMES SR & DORIS A MURPHY
8747 COWART STREET
HOUSTON TX 77029

111. JEWEL MCALPIN
4422 LEE
HOUSTON TX 77020

112. LUVILLIE C DILLARD
3817 WAYNE STREET
HOUSTON TX 77026

113. GRACE BLAIR
4304 NEW ORLEANS
HOUSTON TX 77020

114. NELSON L NEELY & HECTOR M
PAREOES
1426 DEMAREE LN
HOUSTON TX 77029

115. JAMES C JR & ETAL WILLIAMS
1314 BLAND
HOUSTON TX 77091

116. JOHN W RANDLE
2310 WACO
HOUSTON TX 77020

Geology Report

Attachment B

December 22, 2003
W.O. #422-102/60
Union Pacific Railroad
Houston Wood Preserving Works
Houston, Texas

Environmental Resources Management
1110 Montlimar Drive, Suite 150
Mobile, Alabama 36609
(251) 380-0046

Section IV

December 22, 2003
W.O. #422-102/60
Union Pacific Railroad
Houston Wood Preserving Works
Houston, Texas

Environmental Resources Management
1110 Montlimar Drive, Suite 150
Mobile, Alabama 36609
(251) 380-0046

IV. GEOLOGY REPORT SUMMARY

Appendix number(s) of the Geology Report(s): IV

A. Regional Physiography and Topography

Distance and direction to nearest surface water body:

one mile north to Hunting Bayou

Slope of land surface: .4%

Direction of slope: north-northwest

Maximum elevation of facility: 47

Minimum elevation of facility: 46.2

B. Regional Geology

Stratigraphy: The surficial soils of this region are deposits of the Pleistocene fluvial-deltaic system. The generalized stratigraphic column of the upper 1000 feet of the site consists primarily of sand, silt, clay and shell which have been deposited within the last 1.8 million years (Quarternary Period). The youngest sediments comprise the Recent-Holocene (post glacial) depositional surface which is composed of deltaic and coastal interdeltaic plains. The Pleistocene coastal plain occurs between the Recent formations near the coast and the youngest Tertiary formation inland.

Structural setting:

Coastal Plain deposition in geosyncline. Salt diapirs, growth faults, and subsidence constitut primary structural features of this part of the Gulf Coast

C. **Active Geological Processes**

Faults:

No known faults exist in the vicinity of Englewood Yard

Subsidence: Studies by Harris-Galveston Coastal Subsidence District indicate a subsidence rate of about 0.06 ft per yr based on extensometer data collected from a location 1.3 miles west southwest of the closed surface impoundment.

Geomorphic Processes: Pleistocene crevasse-splay deposits, fluvial deltaic geomorphic processes. Currently no active geomorphic processes are significant within the closed surface impoundment.

Are there any wetlands within the property boundary of the facility?

____ YES _X_ NO

D. **Regional Aquifers**

Description: The interpreted bases of the Chicot and the Evangeline aquifers are about 600 and 2000 feet deep, respectively. Relative proportions of sand and clay beds in the Evangeline and the Chicot aquifers vary throughout the area; generally they average half sands and half clays. The Alta Loma Sand (not present at this location) of the Chicot Aquifer is a massive unit. The Evangeline Aquifer consists of less massively bedded sands.

Water-bearing properties: The hydraulic conductivity (coeffcient of permeability) of sands in the Evangeline Aquifer is generally in the range of 150 to 400 gallons per day per squa foot. The storage coeffcient used in the HGCSD Phase II model for the Evangeline Aquifer was estimated to be approximately 0.004. The local transmissivity of the Evangeline Aquifer is about 24000 square ft/day. The Chicot and Evangeline aquifers are under artesian conditions in the area of the closed surface impoundment.

Water quality: Good; TDS = 200 to 600 mg/l in Chicot and Evangeline production sands. Poor quality in zones shallower than the Alta Loma Sand

E. Waste Management Area Subsurface Conditions

Depth below grade (ft)

	0-20	20-30	30-40	40-60	60-80	100
number of borings:	1	13		4		

maximum depth: 50 feet below grade

-4 feet above MSL

stratigraphy: Stratum 1: Shallow Sandy Clay; Stratum 2: El +35 ft Sand

Stratum 3: Intermediate Sandy Clay; Stratum 4: El +15 ft Sand;

Stratum 5: Deeper Clay

STRATUM	VALUE	LIQUID LIMIT	PLASTICITY INDEX	% PASSING -200 SIEVE	K (cm/sec)
1	minimum	32	17	-	7.6×10^{-9}
	maximum	54	39	-	1.7×10^{-8}
	average	43	29	54	1.2×10^{-8}
2	minimum	-	-	-	2.6×10^{-3}
	maximum	-	-		5.0×10^{-3}
	average				3.0×10^{-3}
3	minimum	29	12	79	5.3×10^{-8}
	maximum	57	37	85	3.9×10^{-7}
	average	41	24	82	2.2×10^{-7}
4	minimum	-	-	-	-
	maximum	-	-	-	-
	average	-	-	-	-
5	minimum	61	38	-	-
	maximum	65	42	-	-
	average	64	40	-	4.4×10^{-9}

Permeable, water-bearing strata: ______

El +35 ft sand and El +15ft sand appear to be in good hydraulic connection.

Number of water level measurements: 4

Maximum static water level: 7.5 feet below grade

46. feet above MSL

static water level measured /in monitor well ~~XXXXXhoursxafterxdrilling~~

initial water level for the above well: /no information feet below grade

/no information feet above MSL

date of the above water level measurement: 4/19/91

Minimum static water level: 2.56 feet below grade

43.49 feet above MSL

initial water level for the above well: /no information feet below grade

/no information feet above MSL

date of the above water level measurements: 4/1/91

Flow in direction of uppermost water-bearing stratum: ______

Generally toward the west-northwest, with possible variation

from due west to north-northwest

Hydraulic gradient: ______

0.0005 to 0.005 El + 35 ft Sand

TWC-0376 (Rev. 10-22-90)

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GEOLOGY REPORT

TEXT

TABLES

TABLE of CONTENTS

(continued)

GEOLOGY REPORT

EXHIBITS

ATTACHMENTS

Text

December 22, 2003
W.O. #422-102/60
Union Pacific Railroad
Houston Wood Preserving Works
Houston, Texas

Environmental Resources Management
1110 Montlimar Drive, Suite 150
Mobile, Alabama 36609
(251) 380-0046

GEOLOGY REPORT

Southern Pacific Transportation Company

Englewood Yard - SWR 31547
4910 Liberty Road
Houston, Texas

Site Description

Southern Pacific Transportation Company (SPTCo) closed a surface impoundment in 1984 (SWR31547) at the Englewood Yard, 4910 Liberty Road, Houston, Texas. Englewood Yard is is located approximately one mile north of Interstate Highway 10, off Lockwood Drive, as more fully shown on Exhibit 1. The area is predominantly surfaced with asphalt, concrete and road base material. There are several sets of railroad tracks terminating within and passing through the yard.

The closed surface impoundment at the western end of the yard (see Exhibit 1) is the specific solid waste management unit at this location which will be the focus of this report. Prior to closure, the unit was used to contain creosote contaminated soils.

Topography

The topography in the area of the closed surface impoundment is flat, with an approximate surface gradient of 0.4% from south to northwest. The elevation varies from approximately 47 feet above msl on the southern end of the closed site to approximately 46.2 feet above msl in the northwest. Surface water and drainage features in the immediate area include a shallow ditch which is adjacent to the eastern edge of the closed site, a depression southwest of the site, and a ditch farther southwest that parallels the SPTCo main line.

The regional topography is also flat as shown on Exhibit 2. Two miles to the south of the site, a sharp drop in elevation occurs at Buffalo Bayou. The regional land surface slopes gradually toward the east.

The vegetation on the site consists of grasses indigenous to the area. Wooded areas border the northern and western sides of the closed surface impoundment. The area to the east of the site is surfaced with road base material and supports a series of railroad tracks. An area covered with grass vegetation extends south from the closed surface impoundment to the railroad tracks.

Wildlife on the site appears to be limited to rodents, snakes and birds native to the Harris County area.

Physiography

The site is located within the Brazos Deltaic Plan of the Western Gulf Coast Plain physiographic province, as shown on Exhibit 3. The physiography consists primarily of a relatively flat coastal plain located inland from coastal marshes and inclined gulfward at about five feet or less per mile. The site is composed of surficial clays (compacted fill) underlain by a relict fluvial-deltaic complex which consists of clay, silt, sand and clayey sand deposits.

The main physiographic limitation of the site is one that is common to the Gulf Coast area, i.e. poor drainage resulting from the generally flat topography.

Regional Geology

General

The surficial soils of this region are deposits of the Pleistocene fluvial-deltaic system (Exhibit 4). The generalized stratigraphic column of the upper 1000 feet of the site consists primarily of sand, silt, clay and shell which have been deposited within the last 1.8 million years (Quarternary Period). The youngest sediments comprise the Recent-Holocene (post glacial) depositional surface which is composed of deltaic and coastal interdeltaic plains. The Pleistocene coastal plain occurs between the Recent formations near the coast and the youngest Tertiary formation inland. A stratigraphic column of surface and subsurface units for Harris County is shown on Exhibit 5.

Pleistocene soils underlying the site consist of fluvial, deltaic and associated marginal marine sediments deposited during interglacial stages of rising sea level within the Beaumont, Montgomery, Bentley and Willis formations. In general, these formations are all comprised of similar lithologic material and for the most part do not have persistent individual characteristics that can be recognized in the subsurface. consequently, they have not been correlated satisfactorily in the subsurface of the Harris-Galveston County area.

Shallow Stratigraphy

The interpretation of shallow stratigraphy for this site was derived from the review of manual and electric logs resulting from a series of borings recently completed by Geo Associates. The borings ranged from about twenty- to fifty-foot depth. Of these borings, three were subsequently used for well installations and three for piezometer installations. The boring location plan is included as Exhibit 6. Copies of manual and electric logs are included in Attachment A.

Within the closed surface impoundment, the upper three to seven feet consist of a firm to stiff clay fill. The fill is underlain by a firm to stiff sandy clay (with some fill material) to a depth of twelve to fourteen feet. Below the sandy clay is a water bearing sand, varying in thickness from six to eight feet, and terminating at about nineteen-foot depth. A firm to stiff sandy clay is found from the base of the sand to an approximate depth of thirty feet. From thirty feet to thirty-nine feet there is a very dense sand which is underlain by a very stiff red clay to the fifty-foot termination depths of the borings.

Two stratigraphic cross sections have been prepared for the site. A cross section location map is included As Exhibit 7, while the cross-sections are Exhibits 8 and 9.

Deeper Stratigraphy

The Beaumont Formation is considered the uppermost portion of the Chicot Aquifer. No local wells screen the Chicot, whose base is at about five hundred feet in this area. Local groundwater production in the vicinity of the site is minimal, but wells are screened to about twelve hundred foot depth in the Evangeline Aquifer of Pliocene age.

The generalized deeper stratigraphy near the closed surface impoundment site is shown on Exhibit 10 as adapted from the HGCSD Water Resource Management Program - Phase II. The data shown is based on the interpretation of electric logs of water wells in the Downtown Houston Subsector. The stratigraphic records of these local logs extend to depths of 2150 feet.

Exhibit 10 indicates depths, thickness, hydraulic conductivity and compressibility of clay layers. The intervals between the clay layers represent sand or silt deposits. The local transmissivities of the pumped aquifer is up to about 18000 ft^2/day in the Evangeline Aquifer.

Active Geologic Processes

The active geologic processes of faulting, subsidence and erosion were examined with respect to the closed surface impoundment area. After review of available material, no known faults were observed to intersect the area of the closed surface impoundment. As observed, the site is well sodded with indigenous vegetation , showing no serious evidence of erosion across the surface or adjacent to the site. The principal active geologic process in this vicinity which could affect the site would be subsidence. Subsidence in this portion of Harris County, while once substantial, has been minimized in recent years by the action of the Harris-Galveston Coastal Subsidence District (HGCSD) in limiting groundwater pumpage.

Subsidence

In its Water Management Studies, the HGCSD used the measured rate of subsidence at Benchmark R54 as typical of subsidence throughout the subsector during the period 1965 through 1978. According to the HGCSD Phase II Water Management Study, the rate of subsidence at Benchmark R54 was about 0.18 feet per year. This benchmark is located approximately 1.3 miles west southwest of the closed surface impoundment site and would approximate the probable rate of subsidence in the site area.

The HGCSD Phase II study predicted future subsidence in the downtown subsector during the 1980-2020 period based upon two different scenarios. In the first scenario, the future supply and demand for water usage was estimated; any deficit between available surface water and total water requirements was designed to be met by groundwater pumpage. This scenario predicts about five feet of subsidence during the forty year period. The second scenario assumes that future groundwater pumpage will remain the same as that in 1980. This scenario predicts about 2.5 feet of subsidence over the same forty year period.

An Extensometer located in northeast Houston within about three miles of the site that continuously records the compaction of the upper 2250 feet of the subsurface indicated a subsidence rate of about .06 feet per year during the period 1983 through 1988. This change in rate from the predicted could be attributed to the limitation on the use of groundwater by the HGCSD with the resulting increase in use of surface water by municipalities, industries and agriculture.

Wetlands

The closed surface impoundment is relatively flat and slightly elevated over the surrounding areas; there are no wetlands identified on the Englewood Yard.

Regional Aquifers

Aquifer Names

According to the latest nomenclature by the U.S. Geological Survey, the formations which supply water wells in the Harris County area are from the oldest to youngest: the Fleming Formation of Miocene Age; the Goliad Sand of Pliocene Age; the Willis Sand, Bentley Formation, Montgomery Formation, and Beaumont Clay of Pleistocene Age; and Alluvium of Pleistocene and Recent Ages. Three of these four subdivisions are identified as aquifers and one is identified as a confining layer. From oldest to youngest, and deepest to shallowest, the subdivisions are the Jasper Aquifer, the Burkeville Confining Layer, the Evangeline Aquifer, and the Chicot Aquifer.

The Jasper Aquifer and the Burkeville Confining Layer are considered to be parts of the Fleming Formation. The Evangeline Aquifer includes the upper part of the Fleming Formation and the Goliad Sand. The Chicot aquifer includes the remaining formations up to the land surface. These aquifers are indicated on Exhibit 5.

Constituent Materials

Exhibits 11 and 12 show an interpreted geologic section in the area of the site, taken from the HGCSD Phase I Water Resource Management Program. The interpreted bases of the Chicot and the Evangeline aquifers are shown on Exhibits 13 and 14. Relative proportions of sand and clay beds in the Evangeline and the Chicot Aquifers vary throughout the area; generally, they average half sands and half clays. The Alta Loma Sand (not present at this location) of the Chicot Aquifer is a massive unit. The Evangeline Aquifer consists of less massively bedded sands.

Aquifer Description

The hydraulic conductivity (coefficient of permeability) of sands in the Evangeline Aquifer is generally in the range of one hundred fifty to four hundred gallons per day per square foot. The storage coefficient used in the HGCSD Phase II model for the Evangeline Aquifer was estimated to be approximately 0.004. The local transmissivity of the Evangeline Aquifer is about 24000 ft^2/day.

Aquifer Conditions

The Chicot and the Evangeline Aquifers are under artesian conditions in the area of the closed surface impoundment.

Hydraulic Connection

Sand beds in the Chicot Aquifer are hydraulically connected to some extent with the sand beds in the underlying Evangeline Aquifer and water moves slowly through circuitous routes from one aquifer to another in response to head differences between the aquifers. The two aquifers have been separately identified by the USGS on the basis of production screenings, and the degree of hydraulic connection between the aquifers is not high.

Regional Water Table Contour Map

The USGS has maintained records of the potentiometric surface elevations in wells in this area over a period of years. The potentiometric surface elevations shown on Exhibits 15 and 16 for Spring 1986 are those interpreted for the Chicot and Evangeline Aquifers in this part of the region.

The potentiometric surface elevations in aquifers beneath the closed surface impoundment have risen somewhat since 1977. Chicot potentiometric surfaces have risen approximately ten (10) to twenty (20) feet during the period 1977 - 1990, and Evangeline potentiometric surfaces have risen approximately forty (40) to fifty (50) feet in the same period, according to USGS Open File Report 90-132.

Flow Rate

The flow rate in aquifers is often dominated by the extent of well pumpage. The Chicot and Evangeline aquifers are extensively screened and since most groundwater flow is toward production in wells, the calculation of flow rates in feet per year is not a meaningful exercise. A more useful measurement would be the total groundwater production for the area. Total pumpage in Harris-Galveston Coastal Subsidence District for 1976 was 457 million gallons per day, dropping to 354 million gallons per day in 1987. The closed surface impoundment is located on the western edge of HGCSD sector six, which showed pumpage rates from 120 million gallons per day in 1970 to a high of 170 million gallons per day in 1982, with a recent drop to 140 million gallons per day in 1987. HGCSD records reflect no pumpage during 1990 in an area within one mile radius of the site.

Dissolved Solids Content of Groundwater

Generally, the water from these aquifers is of good chemical quality. Water is considered to be fresh if its total solids content is 1,000 mg/l or less. The general range for total dissolved solids in the water from the producing zones of the Chicot and Evangeline is 200 to 600 mg/l.

Recharge Areas

The Chicot Aquifer recharge area is in northwestern Harris County, southern Montgomery county, and adjacent areas. The Evangeline recharges farther northwest in Grimes, Walker, and northern Montgomery counties (see Exhibit 17). The Beaumont Clay near land surface in much of southern Harris County restricts the amount of recharge to the Chicot Aquifer from the land directly above it.

Groundwater Withdrawal

All of the currently known pumpage in the vicinity of Englewood Yard is from the Evangeline Aquifer. In the southeast Harris County area, the Chicot Aquifer provides most of the water. Most of the water withdrawn from these aquifers is for public supply and industrial use.

The listing of water wells within a one mile radius of the center of the closed surface impoundment (latitude 29°47'08" and longitude 95°19'26") as reported by HGCSD is included in Table 1. These two wells, designated as 1967 and 1968 and are owned by Southern Pacific Transportation Company. They are located approximately three-fourths of a mile east of the closed surface impoundment. The wells have identical latitudinal and longitudinal coordinates and are screened in the Evangeline Aquifer. The records of HGCSD show no pumpage from these wells during 1990.

Waste Management Area Subsurface Conditions

Subsurface Soils Investigation

Historical Borings

Two subsurface investigations are known to have been conducted at this site. The investigations and information reviewed for this report were performed by Professional Service Industries, Inc. (PSI) in April 1984 and Geo Associates in March/April 1991.

PSI

During April 1984, PSI drilled five borings around the perimeter of the closed surface impoundment. The first was used to classify subsurface strata beneath the site. The other four were subsequently used to install groundwater monitoring wells. Copies of boring logs are included in Attachment A.

The first PSI boring (SP1) was drilled near the northwest corner of the site. According to PSI documentation, the boring encountered a sandy clay to fourteen-foot depth. A sand was noted to exist between fourteen and seventeen and one-half foot depth. A clay, with sand seams between thirty and thirty-seven feet and between forty and fifty feet was found from seventeen and one-half to the termination depth of fifty feet.

Some variations from the stratigraphy noted in SP1 were found in borings used for PSI well installations. They included a red clay from the surface to five and one-half foot depth in SP4 (Well 1) and a silty clay from twelve to fourteen-foot depth in SP2 (Well 2). The top of sand was generally found to occur at thirteen to fifteen and one-half foot depth.

Geo Associates

During March 1991, Geo Associates drilled and logged a series of borings which were designed to accomplish the following: a) to provide additional stratigraphic information; b) to investigate the potential for residual chemical contamination to exist in the closed surface impoundment area by means of soil chemical analyses; and c) to provide additional groundwater information through the installation of additional monitoring wells and piezometers in conjunction with the Groundwater Quality Assessment Plan.

Four borings (P10, P11, P12 and B13) were drilled external to the closed surface impoundment and terminated at fifty-foot depth; Borings P10, P11, and P12 were converted to piezometer installations. Five borings (B-A1, B-B3, B-C1, B-D3, B-F2 and B-G4) were drilled within the closed surface impoundment and were terminated at twenty-two foot depth. Borings 7, 8, and 9 were utilized for the installation of Monitor Wells 7, 8, and 9.

Drilling techniques used in the investigation were wet rotary with continuous sampling to twenty feet and at five foot intervals thereafter. Wells were single cased. For piezometers which were installed through possibly contaminated sands/silts and screened in a lower zone, multiple casing techniques were used to minimize the possibility of cross contamination. Supervision of drilling was provided by an engineer or geologist.

A list of monitor wells are included on Table 2. Manual logs and electric logs of selected borings are included in Attachment A . Soils geotechnical laboratory data is included in Attachment B.

Stratigraphic Interpretations and Cross Sections

Air photo interpretation, review of available geologic data and review of the recent boring logs have been used to interpret the site's shallow stratigraphy. This interpretation and the hydrographs of selected wells has allowed the definition of two permeable zones within the upper fifty feet of the site. Deeper zones have not been investigated. Based on these data, the following shallow permeable zones are indicated:

El +35 ft Sand	This zone was encountered at a depth of about twelve to fourteen feet or top about elevation 35. The sand varies in thickness from about six to eight feet. Monitor wells 1, 2, 3, 4, 5, 7, 8, and 9 screen this zone.
El +15 ft Sand	This sand zone was encountered at a depth of about thirty to thirty-three feet or top about elevation 15. The sand is approximately six to nine feet thick Piezometers 10, 11 and 12 screen this sand zone. From a review of the water levels in this and the El +35 ft sand it appears that the two zones are hydraulically connected.

The interpretation of shallow stratigraphy for this site was derived from the review of manual and electric logs resulting from a series of borings recently completed by Geo Associates. The borings ranged from about twenty- to fifty-foot depth. Within the closed surface impoundment, the upper three to seven feet consist of a firm to stiff clay fill. The fill is underlain by a firm to stiff sandy clay (with some fill material) to a depth of twelve to fourteen feet. Below the sandy clay is a water bearing sand, varying in thickness from six to eight feet, and terminating at about nineteen to twenty-foot depth. A firm to stiff sandy clay is found from the base of the sand to an approximate depth of thirty to thirty-two feet. From thirty-two feet to thirty-nine feet there is a very dense sand which is underlain by a very stiff red clay to the termination depths of the borings.

Two stratigraphic cross sections have been prepared for the site and are included as Exhibits 8 and 9.

Engineering Data

A laboratory testing program was undertaken during the soils investigation by Geo Associates to assist in classification of the soils and to determine the grain size and permeability of some of the retrieved samples. Hand penetrometer tests were performed in the field on the retrieved samples to assist in classification of the consistency of the clay soils. Sieve analyses were accomplished on retrieved samples of the water-bearing silts and sands. Permeability tests on selected samples of the clays were run to determine their laboratory permeability. Atterberg limits, moisture contents, and visual classifications were also conducted in the laboratory to better define the various soils on the site. Laboratory testing was accomplished in accordance with ASTM methods.

The results of laboratory tests for the study are included as Attachment B to this report and/or are indicated on the borings logs included in Attachment A.

Field permeability tests for selected monitoring well locations were conducted by Geo Associates to determine the hydraulic conductivity for the uppermost zone. The results of these tests are discussed in a following section of this report. Hydraulic gradients within the El +35 ft sand are calculated to be in the range of 0.0005 to 0.005 with an average value of 2.3 X 10^{-3}.

Groundwater Investigation Report

Records of Water Level Measurements in Borings and Wells

Water level observations in the wells and piezometers were taken periodically after drilling and converted to msl. Since initial encountering of groundwater is shallow on this site, and since drilling at this location is most appropriately accomplished by wet rotary methods, no initial encountering of the groundwater was reported for well or piezometer installations.

Water level measurements for groundwater monitor wells 1, 2, 3, 4, 5, 7, 8, 9 and Piezometers 10, 11, and 12 were recorded at four intervals. These readings were converted to elevation msl and the tabulated results included on Table 3. Contour maps for the El +35 ft sand for the four measurement intervals have been prepared and are included as Exhibits 18, 19, 20, and 21.

Two permeable zones of the uppermost aquifer are currently included in the study. Monitor wells 1, 2, 3, 4, 5, 7, 8, and 9 screen the El +35 ft sand zone; Piezometers 11, 12, and 13 screen the El +15 ft sand zone. A review of the water level data has been accomplished to establish the possibility of hydraulic connections/separations and the conductivities. This information is more fully discussed in the following sections.

Hydraulic Gradients

Well pumping and slug tests were conducted on El +35 ft sand wells 7, 8 and 9 to evaluate hydraulic conductivity (coefficients of permeability). These in-situ tests resulted in calculated values of hydraulic conductivity ranging from 2.6×10^{-3} to 5.0×10^{-3} cm/sec. A value of 3.0×10^{-3} was used in the velocity calculations.

Hydraulic gradients within the El +35 ft sand are calculated to be in the range of 0.0005 to 0.005 with an average value of 2.3×10^{-3}. Flow is generally toward the west-northwest, with possible variation from due west to north-northwest. Calculated groundwater velocities range in value from 5 to about 52 feet per year with an average of about 24 feet per year using Darcy Equation with an assumed porosity of 30%. The hydraulic gradients and velocities are summarized in Table 4.

The El +15 ft sand was screened by three piezometers to allow a rough estimation of the flow direction and gradient in this zone by triangulation. The observations showed the flow direction and gradient to be comparable to that of the El +35 ft sand, indicating potential hydraulic connection between the two zones.

Monitor wells 7 and 9 are located approximately ten feet from Piezometers 10 and 12. Well 7 and 9 are screened in the El +35 ft sand zone while Piezometers 10 and 12 are screened in the El +15 ft sand zone. A review of the water level elevations (see Table 3) reflects that elevations in monitor wells 7 and 9 are very close to water level elevations recorded in adjacent piezometers 10 and 12. This similarity suggests that the two zones are probably in good hydraulic communication (see Exhibit 22).

Average vertical gradients for the month of April 1991 were calculated for the area near Well 7 and Piezometer 10 and the area near Well 9 and Piezometer 12. Since Well 7 and Piezometer 10 are separated with by approximately thirteen feet of clay, the average vertical gradient is calculated to be approximately 0.0058. In the area of Well 9 and Piezometer 12, the separation is approximately sixteen feet of clay, with an average calculated gradient of 0.0011.

The vertical gradients are summarized in Table 5 and the gradient calculations included in Attachment C.

The variation in gradients during the month of April 1991 may be related to two events: a) the very heavy rainfall during March and April 1991; and/or b) a leak in a water line located near the site. The Houston area experienced excessive rain during March and April 1991, keeping soils saturated and contributing to overall hydrostatic pressures in the shallow permeable zones. The water line was leaking below ground surface in the area between Well 9 and Well 8. The line was repaired on March 28, 1991, but the local pore pressures in the soils may have affected the local groundwater gradients for a period of time after repair.

Pathways for Pollution Migration

The most likely pathway for pollution migration into the groundwater at this site would be through the vertical movement through silty clays beneath the formerly active surface impoundment into the El +35 ft sand. Since there appears to be good hydraulic connection between the El +35 ft sand and the El +15 ft sand as discussed above, there is a likelihood that pollutants could migrate to the lower zone.

It is not likely that migration of pollutants would occur after closure of the surface impoundment. Post closure sampling reported by Rollins Environmental Services indicated that all chemicals detected at the base of the impoundment prior to backfilling were below background levels. Recent soil sampling by Geo Associates in April 1991 reconfirmed these findings (see Attachment D).

Identification of Uppermost Aquifer

The local geology of this site is such that some degree of local connection probably exists between permeable units through the upper several thousand feet of the subsurface. Nevertheless, it is conventional and proper to subdivide the zones into aquifers, each aquifer may be comprised of several zones with relatively good hydraulic conductivity. The hydraulic connection between various aquifers would be considerably less than between permeable zones within each aquifer.

On the basis of the investigations carried out at the site, the El +35 ft sand and the El +15 ft sand zones, within the upper fifty feet of the surface, have been identified as the uppermost aquifer:

a. El +35 ft sand - a sand and clayey sand zone with a thickness of about six to eight feet located between about elevation 35 and elevation 27. The sand is gray and loose on the western half; medium dense on the eastern portion. The clayey sand portion of the zone is found in the upper two feet of the eastern portion of the site.

b. El +15 ft sand - a very dense sand with a thickness of approximately six to nine feet located between about elevation 17 and elevation 8.

A review of water level data for Monitor wells 7 and 9 (El +35 ft sand zone) and Piezometers 10 and 12 (El +15 ft sand zone) reflects that the calculated water level elevations, gradients, and flow directions in both zones appear to be similar. This similarity indicates that the two zones are unique but are probably in good hydraulic communication.

Surface contour maps for the uppermost aquifer are included as Exhibits 23 and 24.

Groundwater Flow Direction and Rate

During the month of April 1991, water levels were measured on four separate occasions in monitor wells and piezometers; measurements were referenced to the top of well casing and converted to elevation msl (see Table 3). Groundwater contour maps were prepared and groundwater flow direction determined.

Hydraulic gradients within the El +35 ft sand are calculated to be in the range of 0.0005 to 0.005 with an average value of 2.3×10^{-3}. Flow is generally toward the west-northwest, with possible variation from due west to north-northwest. Calculated groundwater velocities range in value from 5 to about 52 feet per year with an average of about 24 feet per year using Darcy Equation with an assumed porosity of 30%. The hydraulic gradients and velocities are summarized in Table 4.